



Key Terms

- Energy Carriers
- Fuel Cell
- Fusion
- Radiant Energy
- Renewable

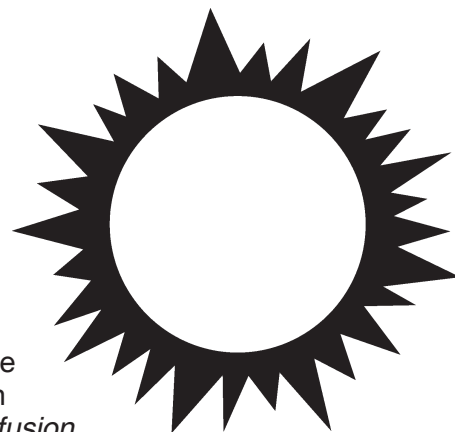
Hydrogen Facts

- Hydrogen is a non-toxic, colorless, odorless and tasteless gas.
- Hydrogen, bound in organic matter and water, makes up 70 percent of the Earth's surface. It is the most common element in the universe.
- Hydrogen is about 1/4 as dense as air.
- Hydrogen burns cleanly. When it is burned with oxygen, the only by-products are heat and water. When burned with air, which is about 68 percent nitrogen, some oxides of nitrogen are formed.
- Most of the hydrogen produced in the United States is made by steam reforming, which is currently the most cost-effective way to produce hydrogen.

Hydrogen

What is hydrogen?

Hydrogen is the simplest element known to man. An atom of hydrogen has only one proton and one electron. It is also the most plentiful gas in the universe.



The sun's energy comes from hydrogen. The sun is a giant ball of hydrogen and helium gases. Inside the sun, hydrogen atoms combine to form helium atoms. This process is called *fusion* and it gives off *radiant* energy. This radiant energy sustains life on earth. It gives us light and makes plants grow. It makes the wind blow and rain fall. It is stored in fossil fuels. Most of the energy we use today comes from the sun.

Hydrogen as a gas (H_2) doesn't exist on earth. It is always mixed with other elements. Combined with oxygen, it is water (H_2O). Combined with carbon, it makes different compounds such as methane (CH_4), coal and petroleum. Hydrogen is also found in all growing things – biomass.

Hydrogen can store energy.

Most of the energy we use today comes from fossil fuels. Only 7 percent comes from renewable energy sources. But people want to use more renewable energy. It is usually cleaner and is replenished in a short period of time. *Renewable* energy sources – like solar and wind – can't make energy all the time. The sun doesn't always shine. The wind doesn't always blow. They don't always make energy when or where we need it. Hydrogen can store that energy until it's needed and move it to where it's needed.

Hydrogen As An Energy Carrier

Everyday we use more energy, mostly coal, to make electricity. Electricity is a secondary source of energy. Secondary sources of energy – sometimes called *energy carriers* – store, move and deliver

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energy to consumers. We convert energy to electricity because it is easier for us to move and use.

Electricity provides light and heat, gives us hot water and cold food and powers our televisions and computers. Life would be hard if we had to burn the coal, split the atoms or build our own dams. Energy carriers make life easier.

Hydrogen is an energy carrier for the future. It is a clean, renewable fuel that can be used in places where it's hard to use electricity. Sending electricity a long way costs four times as much as shipping hydrogen by pipeline.

How is hydrogen made?

Since hydrogen doesn't exist on earth as a gas, we must make it. We make hydrogen by separating it from water, biomass or natural gas. Scientists have even discovered that some algae and bacteria give off hydrogen. It's very expensive to make hydrogen right now, but new technologies are being developed all the time.

Uses of Hydrogen

NASA has used hydrogen for years in the space program. Hydrogen fuel lifts the space shuttle into orbit. Hydrogen batteries – called *fuel cells* – power the shuttle's electrical systems. The only by-product is pure water, which the crew uses as drinking water.

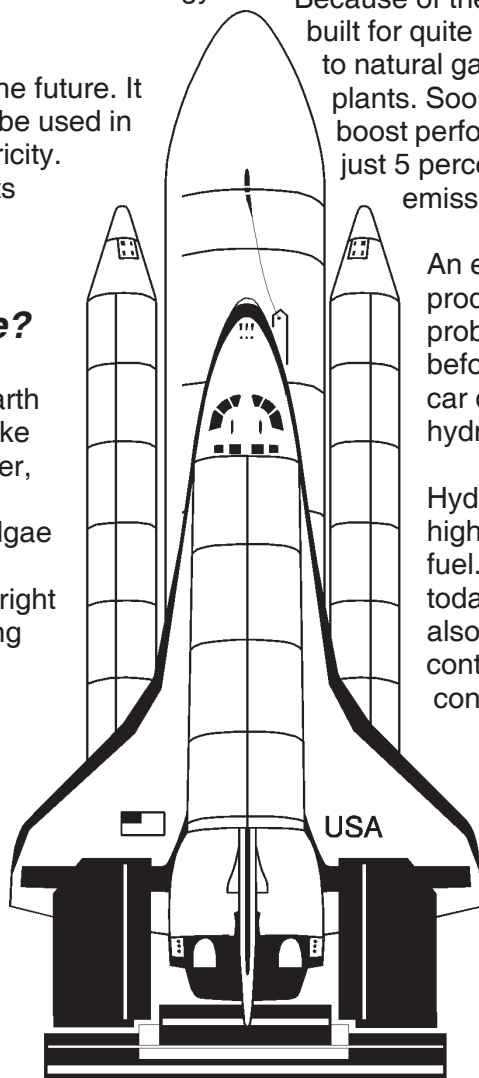
Hydrogen fuel cells (batteries) make electricity. They are very efficient, but expensive to build. Some day, small fuel cells could power electric cars. Large fuel cells could provide electricity in remote areas.

Hydrogen as a Fuel

Because of the cost, hydrogen power plants won't be built for quite a while. Hydrogen soon may be added to natural gas to reduce pollution from existing plants. Soon hydrogen will be added to gasoline to boost performance and reduce pollution. Adding just 5 percent hydrogen to gasoline can lower emissions by 30 to 40 percent.

An engine that burns pure hydrogen produces almost no pollution. It probably will be 20 years, though, before you can walk into your local car dealer and drive away in a hydrogen-powered car.

Hydrogen also would be a great jet fuel. It's high in energy, so jets would need less fuel. And it weighs less than the fuel used today, so jets could carry more cargo. It's also nonpolluting. If the price of jet fuel continues to rise, you might see planes converting to hydrogen in the near future.



The Future of Hydrogen

Before hydrogen can take its place in the U.S. energy picture, many new systems must be built. We will need systems to make hydrogen, store it and move it. We will need pipelines and fuel cells. And consumers will need the technology and the education to use it.



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